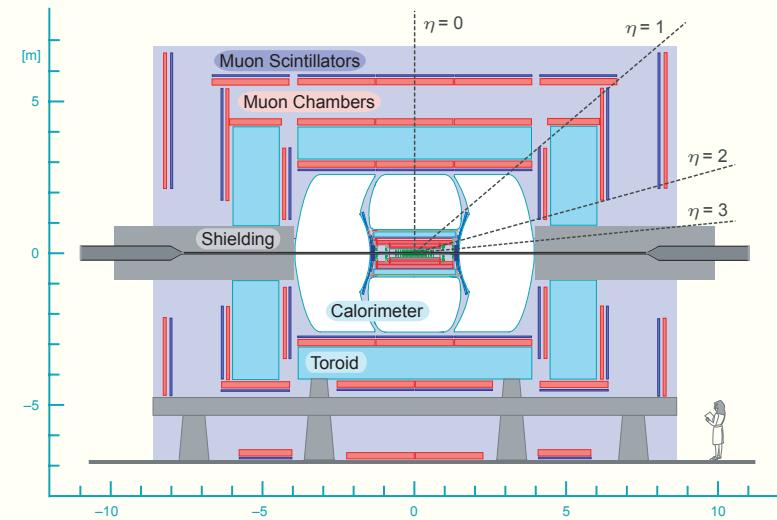
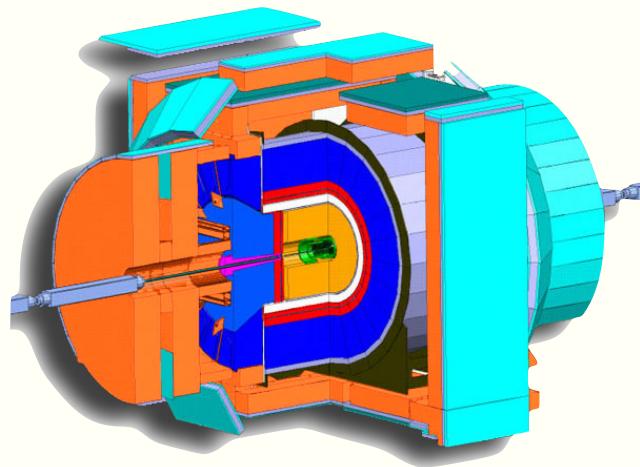
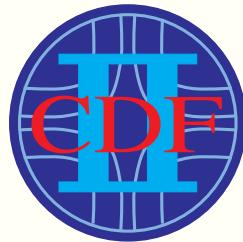


Searches for Same Sign Charge Dilepton Events and WZ Resonances at the Tevatron

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Representing the CDF and DØ Collaborations



35th International Conference on High Energy Physics
Paris, July 2010

There are MANY models that describe possible New Physics

Seven models to be covered here...

Sequential standard model (SSM)

Low scale technicolor

Extra dimensions

Extended gauge models

Heavy 4th generation quarks

Maximal flavor violation

Supersymmetry (MSSM, mSUGRA)

+ model independent

The signatures are the tools to investigate these models of New Physics

**Dileptons,
Trileptons,
Jets,
Missing Energy,
Photons**

**Direct decays,
resonances**

Six analyses are presented here

**Same-sign dilepton analyses and
WZ resonance analyses
from CDF and DØ**

Starting with the $\ell^\pm\ell^\pm$ analyses...

Same sign dileptons are a great signature for New Physics

... because $\ell^\pm\ell^\pm$ events are uncommon in SM processes thus backgrounds are low

4 types of background sources of $\ell^\pm\ell^\pm$ include...

On & off shell dibosons: WZ , ZZ

Drell-Yan with radiated γ that converts asymmetrically, $Z\gamma$, $W\gamma$ (γ converts)

$W+j$, $Z+j$ where jet is misidentified as lepton,
Semileptonic $t\bar{t}$ where jet is misidentified as lepton

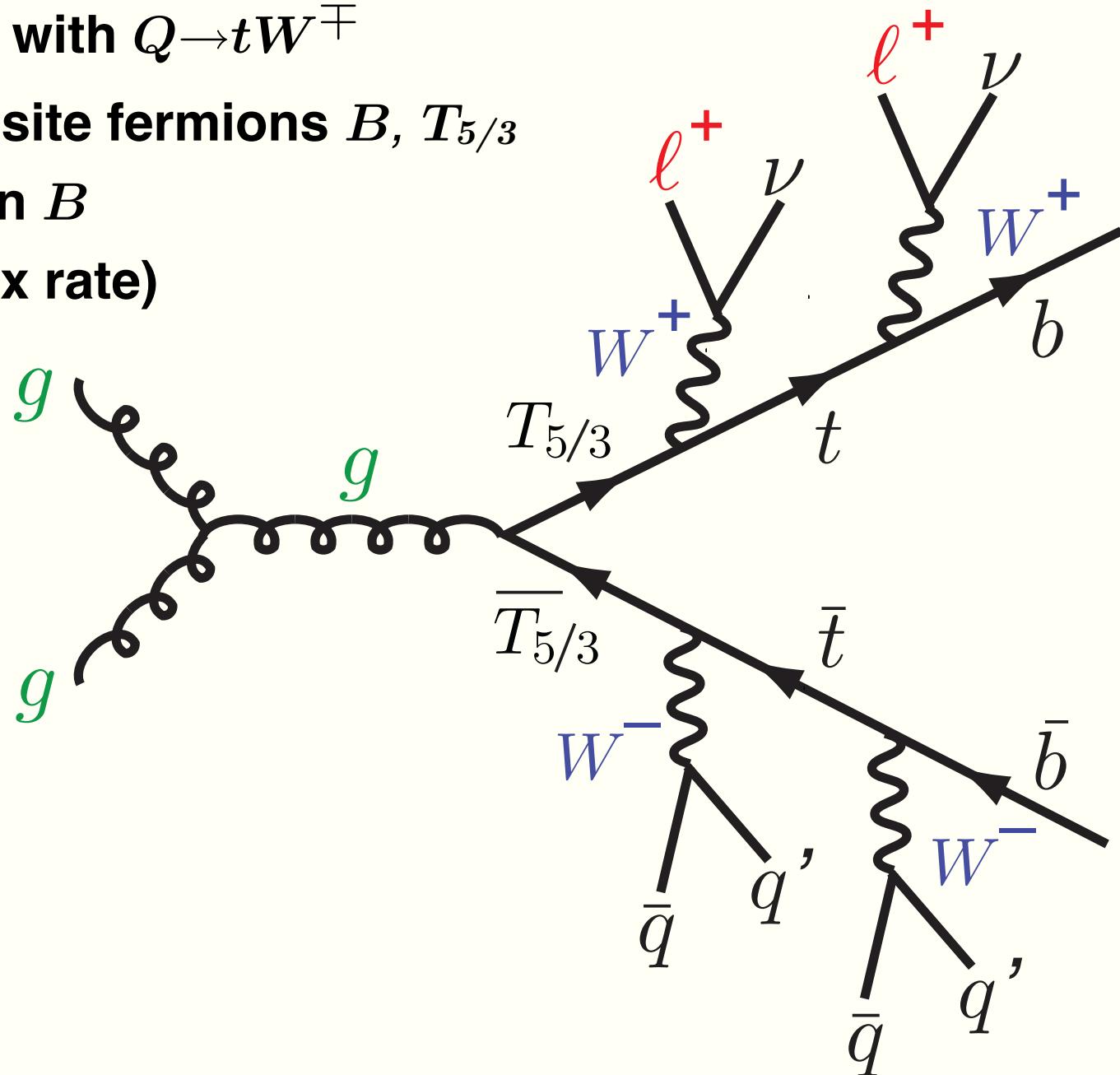
Opposite sign dilepton events but one charge is misidentified

1) CDF searched for 4th generation fermions with $\ell^\pm\ell^\pm$

Examine models with $Q \rightarrow tW^\mp$

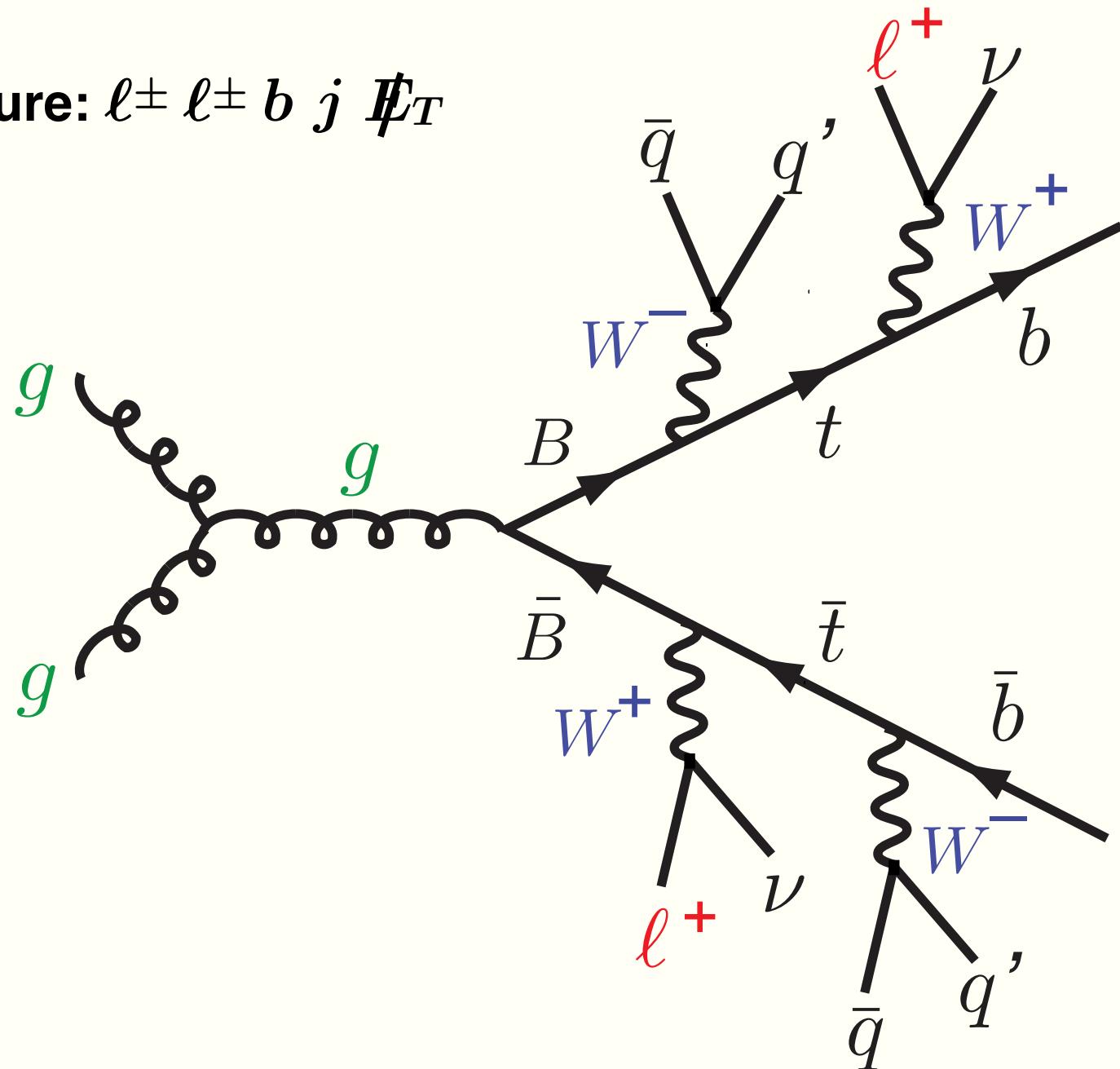
$Q = b'$ or composite fermions $B, T_{5/3}$

If $T_{5/3}$ exists, then B
must exist too (2x rate)



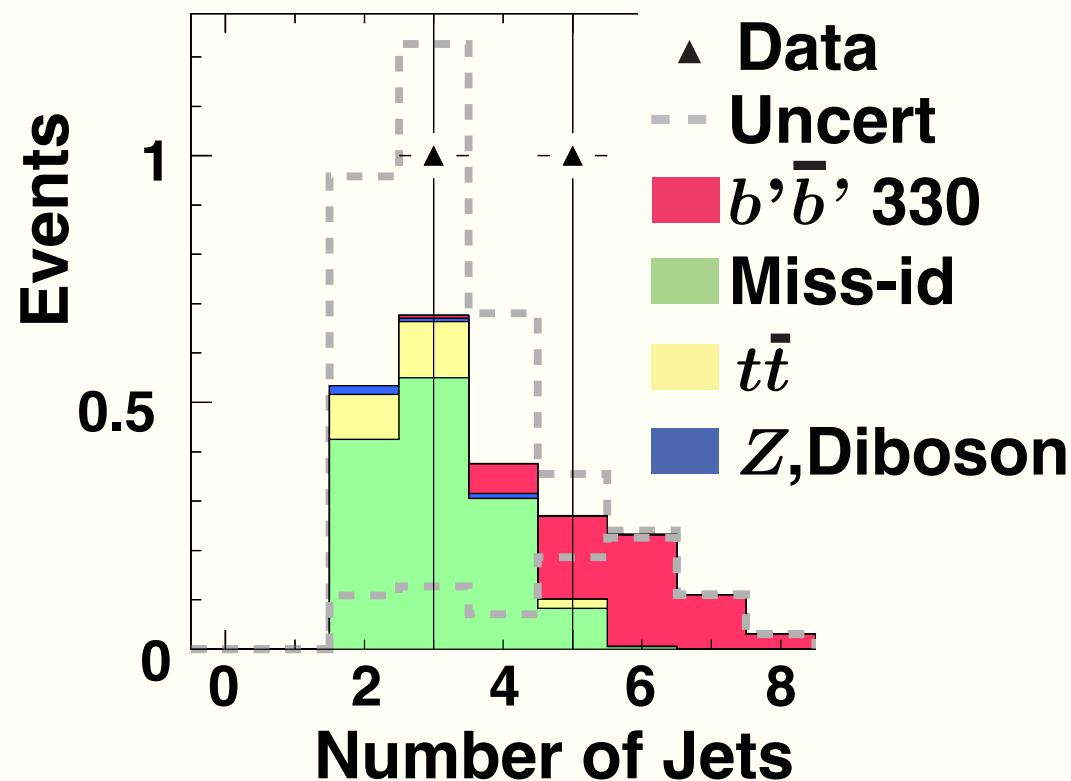
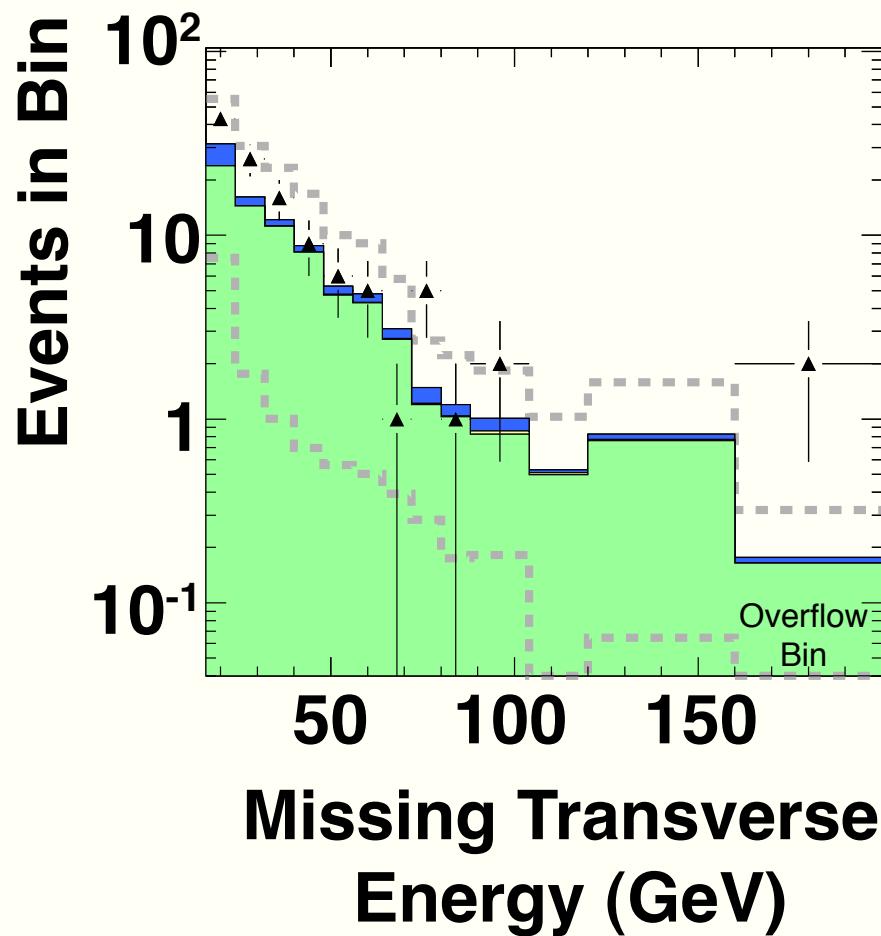
... bottom-like quark or composite fermion

Require signature: $\ell^\pm \ell^\pm b j \cancel{E}_T$

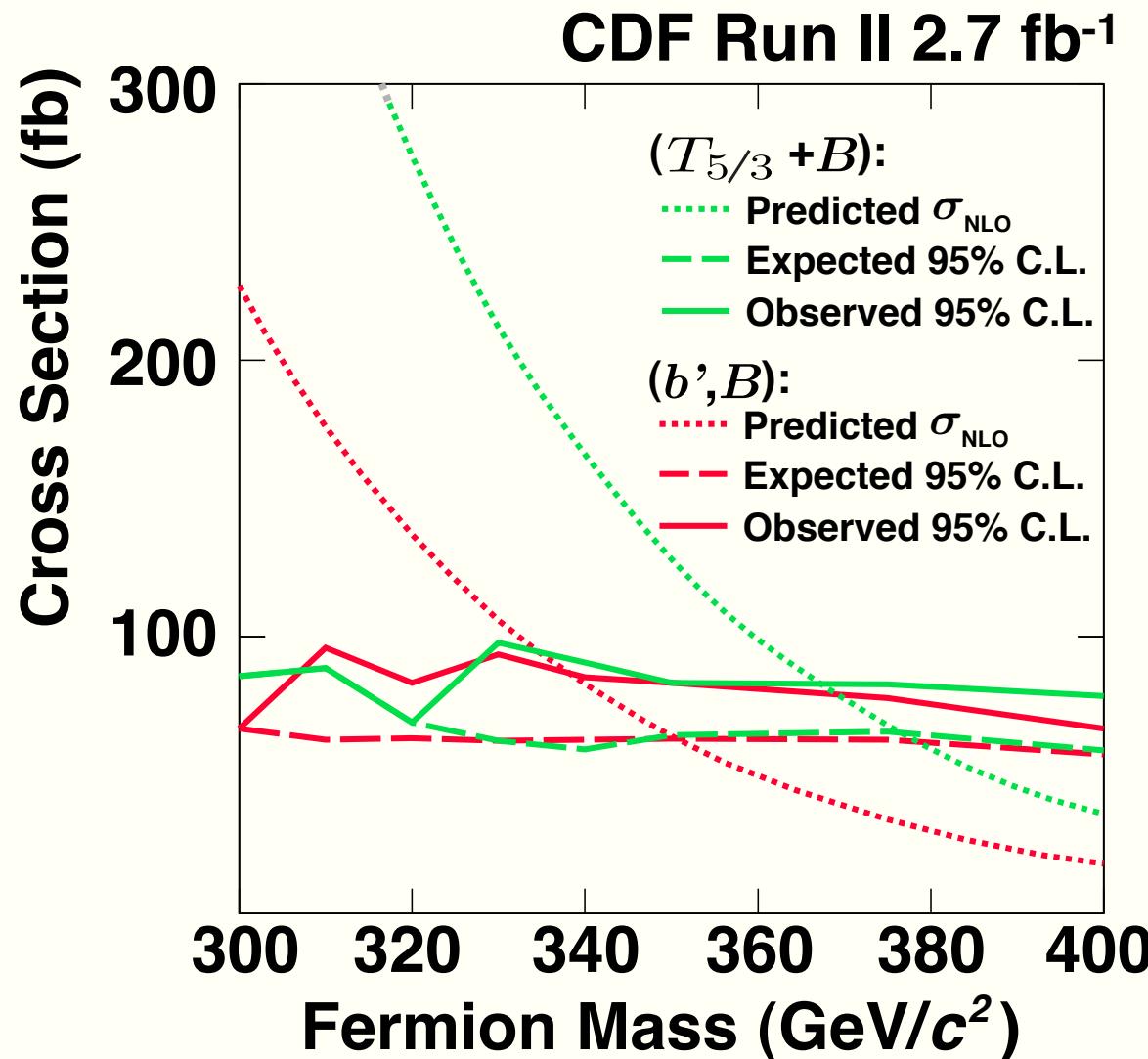


No heavy 4th generation fermion signal was observed

In 2.7 fb^{-1} , expect 1.6 ± 1.4 events background
2 events were observed



Limits were set on heavy fermion masses by CDF



PRL 104, 091801
(2010)

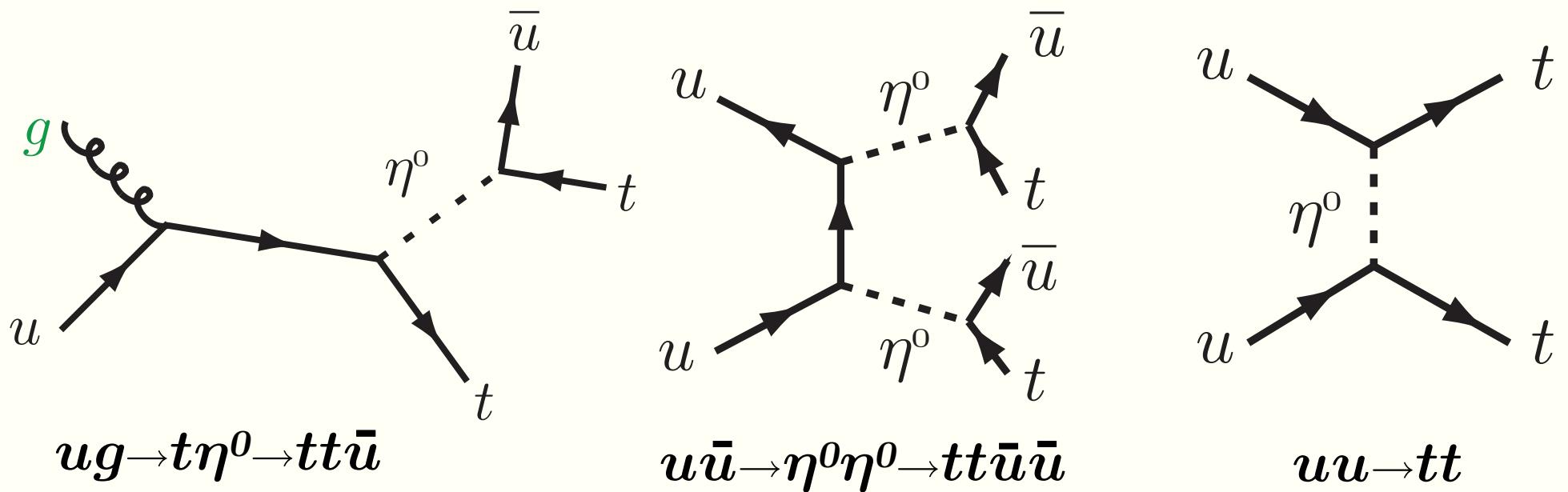
$m_{b',B} > 338 \text{ GeV}/c^2 \quad m_{T5/3} > 365 \text{ GeV}/c^2 @95\% \text{ C.L.}$

2) CDF searched for maximal flavor violating scalars using $\ell^\pm\ell^\pm$

The SM favors minimal flavor violation (MFV) in the quark sector.
Does New Physics follow this rule too?

Maybe not! Investigate **MAXIMAL** Flavor Violation (MxFV)...

New scalar field $\Phi_{FV} = (\eta^0, \eta^+)$ that couples to quarks with coupling ξ_{ij} . MxFV₁ has coupling matrix terms $\xi_{31}, \xi_{13} \sim 1$

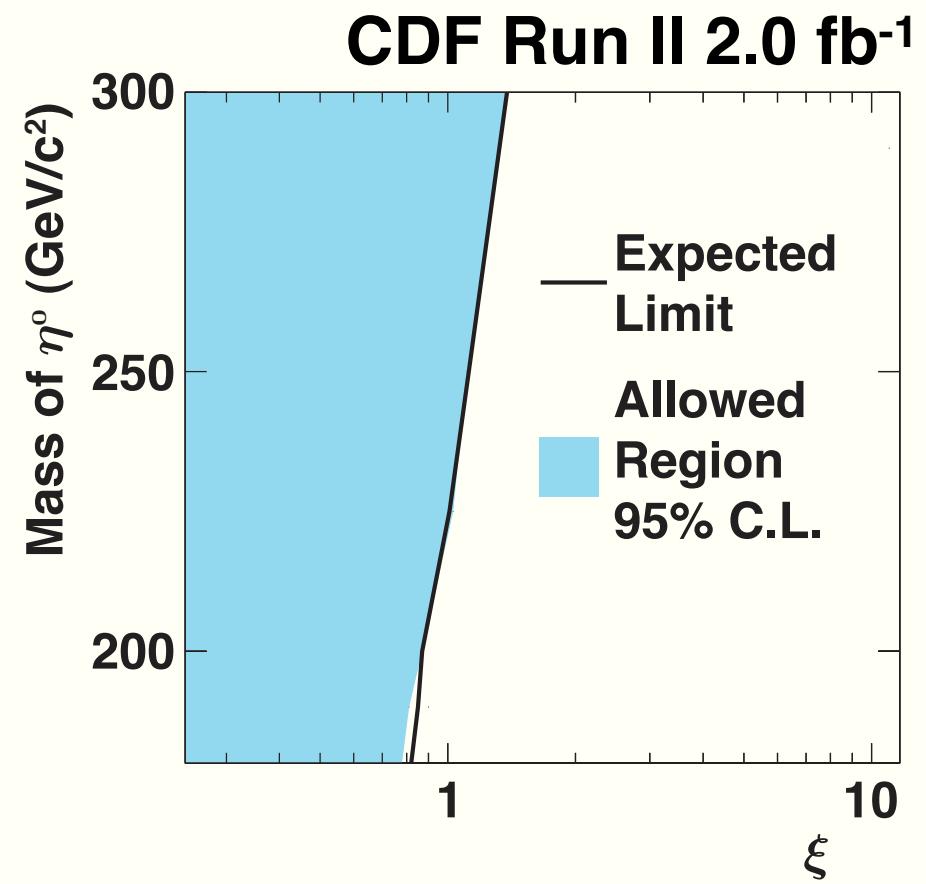
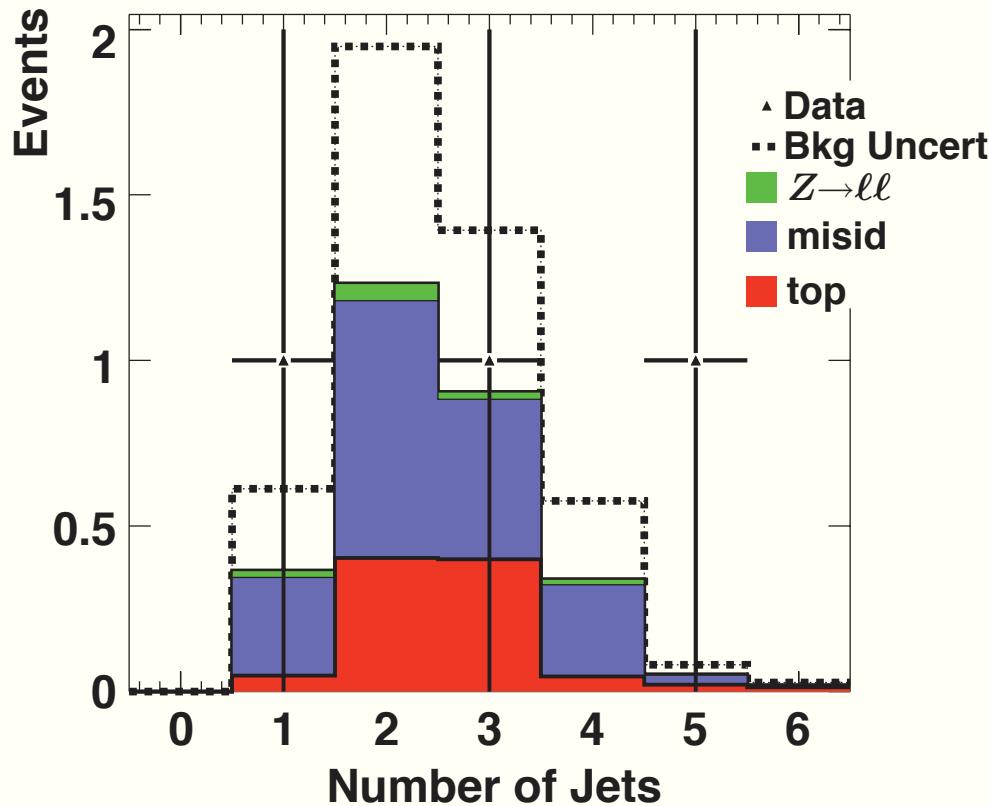


Use two same sign tops to search for MxFV

Require signature (two same-sign tops!): $\ell^\pm \ell^\pm b \not{E}_T$

In 2.0 fb^{-1} , expect 2.1 ± 1.8 events background

3 events were observed

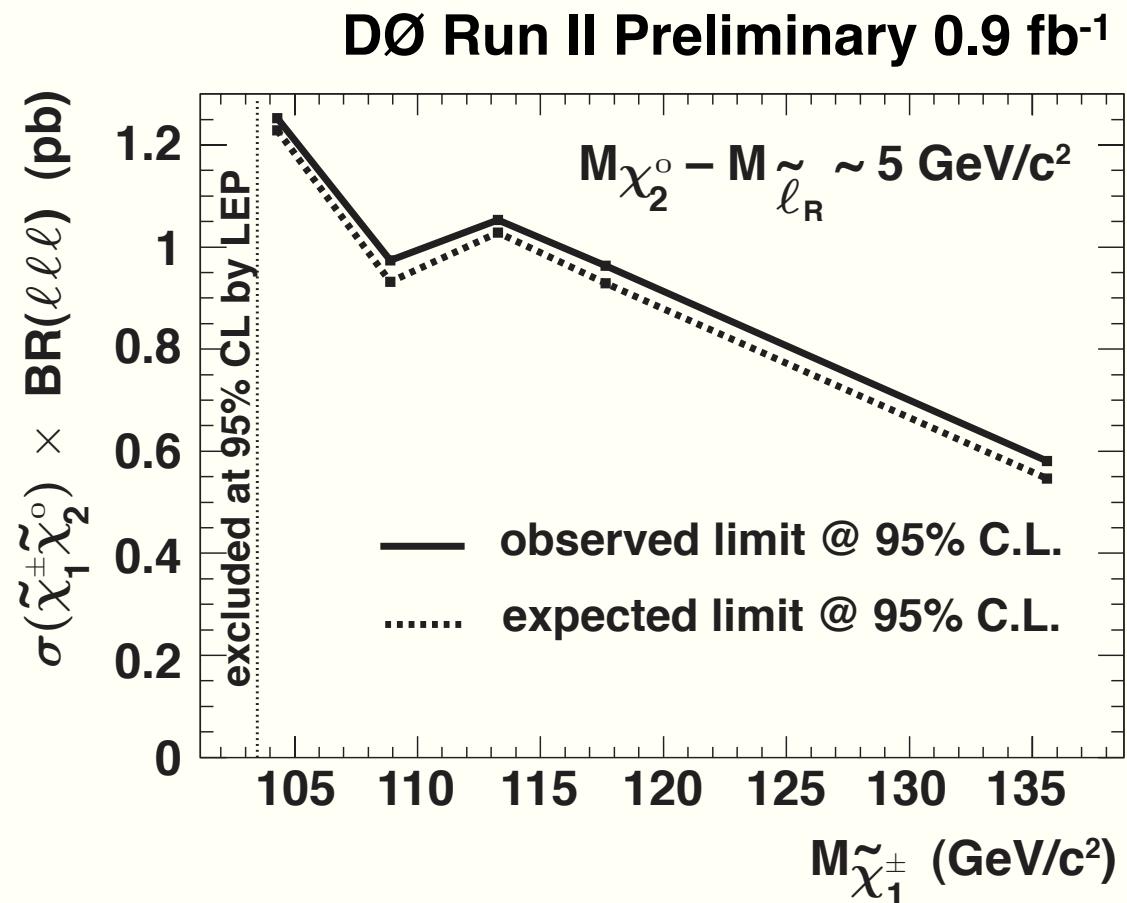


3) DØ searched for associated chargino/neutralino production with same sign $\mu\mu$

Some mSUGRA models yield trileptons with a very soft 3rd lepton.

Instead, require same sign dimuons to recover some acceptance while restricting backgrounds

In 0.9 fb⁻¹, expect 1.1 ± 0.4 events background
1 event was observed



4) CDF searched for generic New Physics using $\ell^\pm\ell^\pm$

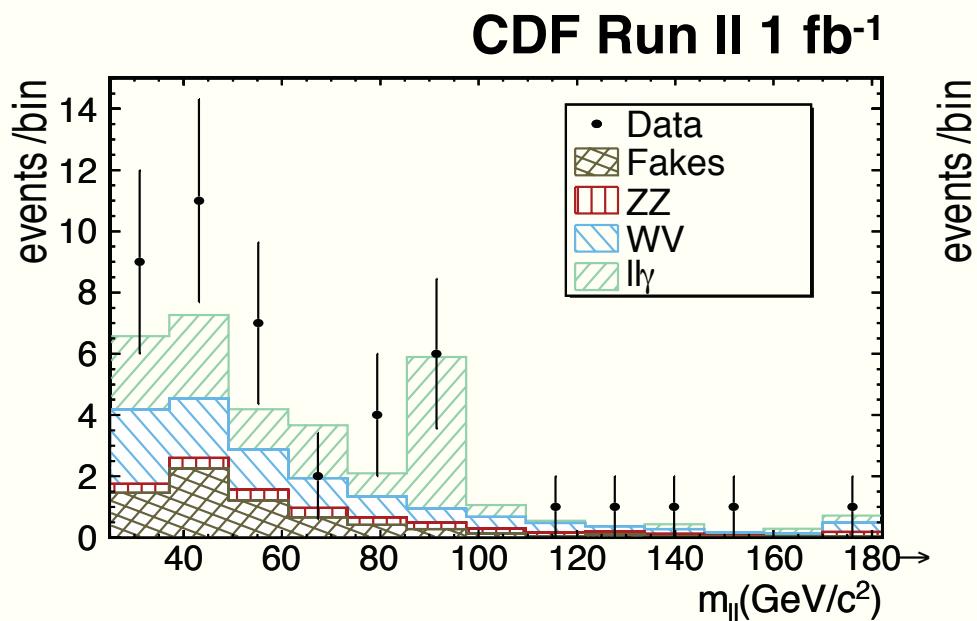
With a model, you can optimize the analysis for maximal discovery reach

... BUT, what if no one has a model for the New Physics that might actually be present? Experiments could miss it!

Search for central, same sign dilepton events with $E_{T1} > 20$ GeV; $E_{T2} > 10$ GeV

	n_{obs}	n_{pred}	$n_{\ell\ell\gamma}$	n_{WV}	n_{ZZ}	n_{fake}
$e_{\text{Si}}e_{\text{Si}}$	11	6.3 ± 1.0	3.2	1.4	0.4	1.3
ee	3	1.3 ± 0.3	0.9	0.1	0.0	0.2
$e_{\text{Si}}e$	9	9.1 ± 1.8	6.4	1.6	0.1	1.0
$e_{\text{Si}}\mu$	11	6.8 ± 0.8	0.8	2.8	1.1	2.1
$e\mu$	5	6.4 ± 1.2	3.4	1.9	0.2	0.9
$\mu\mu$	5	3.2 ± 0.3	0.1	1.4	0.8	0.8
Total	44	33.2 ± 4.7	14.9	9.3	2.5	6.4

PRL 98, 221803 (2007)



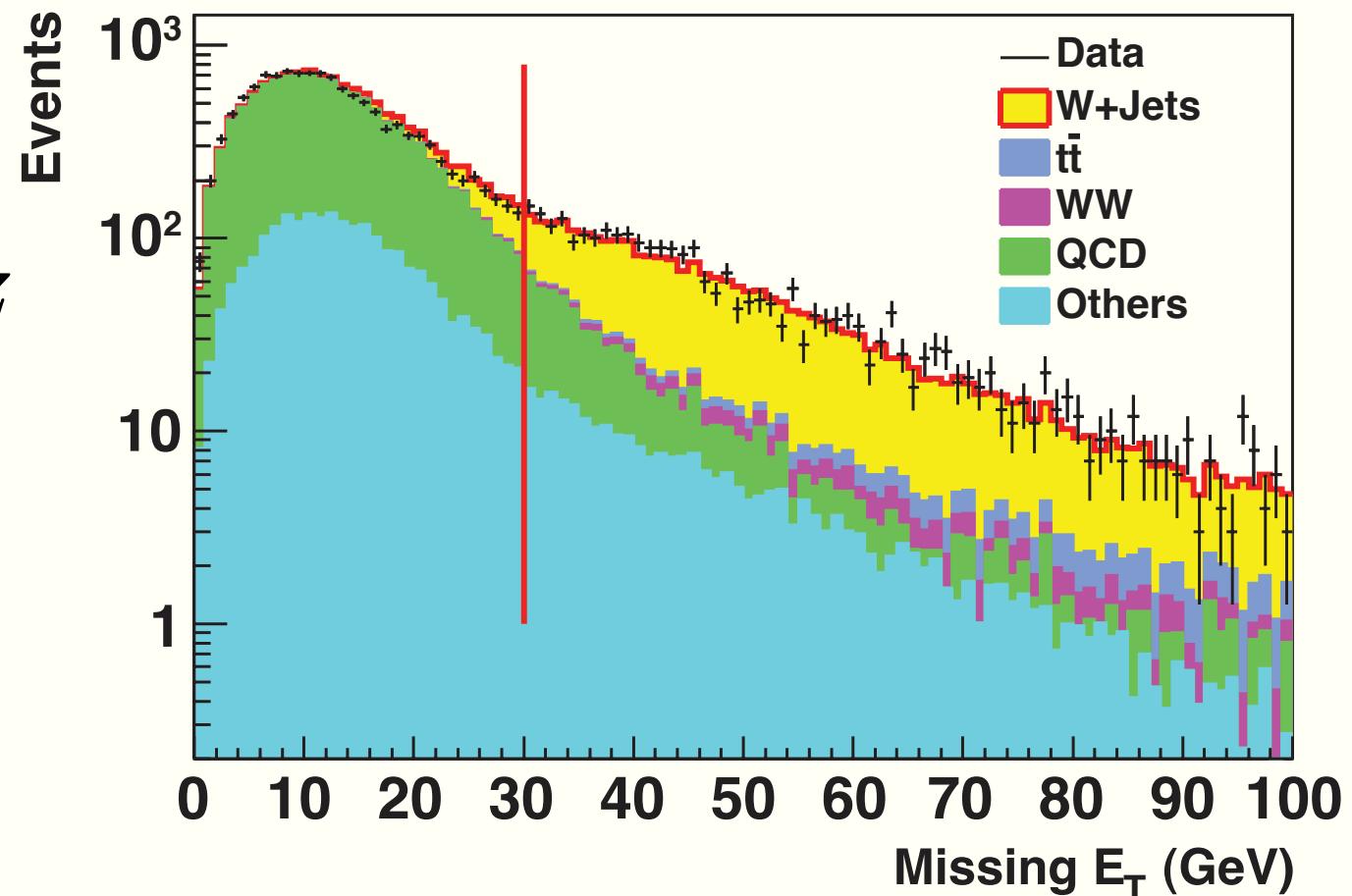
**Investigate more BSM models using
*WW/WZ Resonances...***

5) CDF searched for W' , Z' , and G^* decaying to dibosons (WW and WZ resonances)

For extended gauge, set limits on mass and gauge coupling strength. $g \cos\theta_w \rightarrow \xi g \cos\theta_w \quad \xi = C(M_W/M_V)^2$

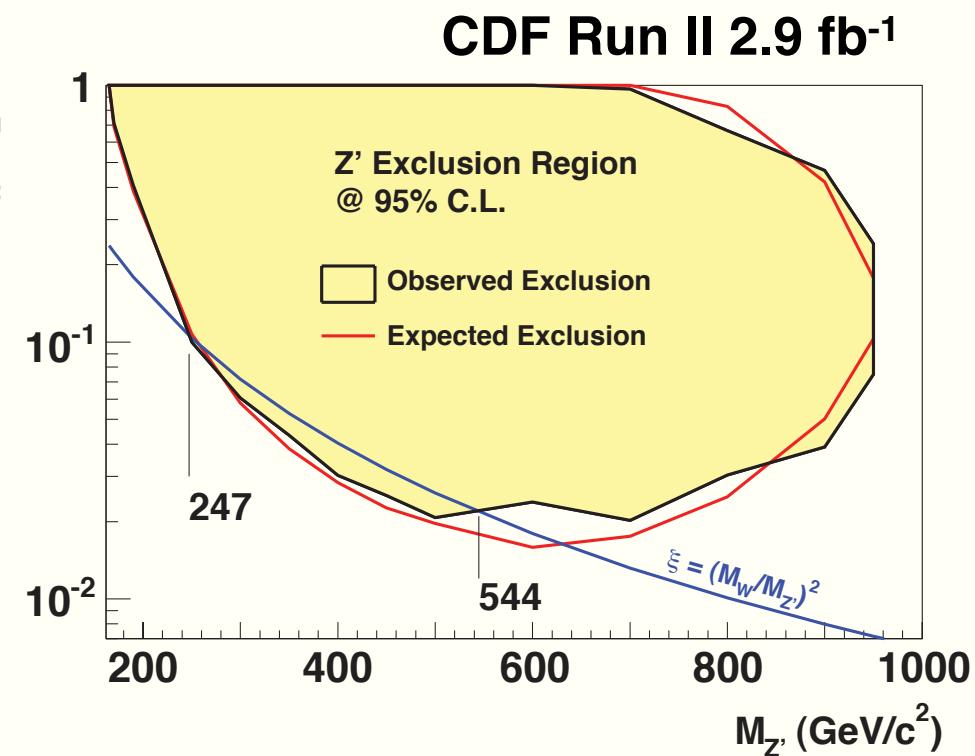
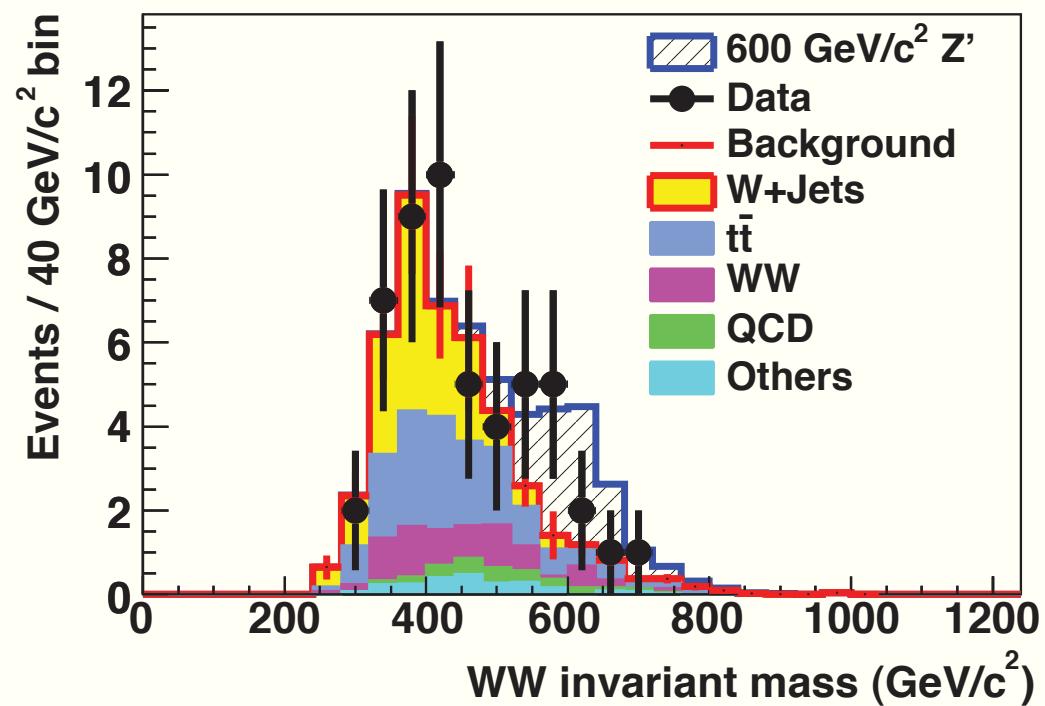
Require signature:
 $e\nu jj$

Reconstruct W and Z
to form WW or WZ



Limits were set on extended gauge models...

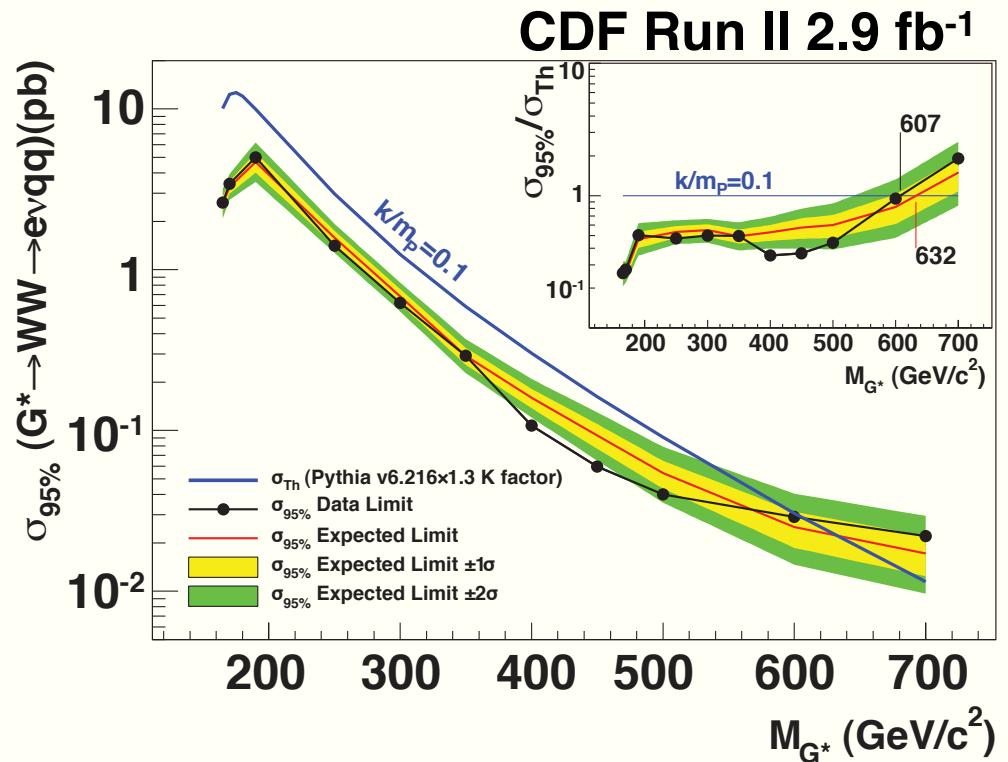
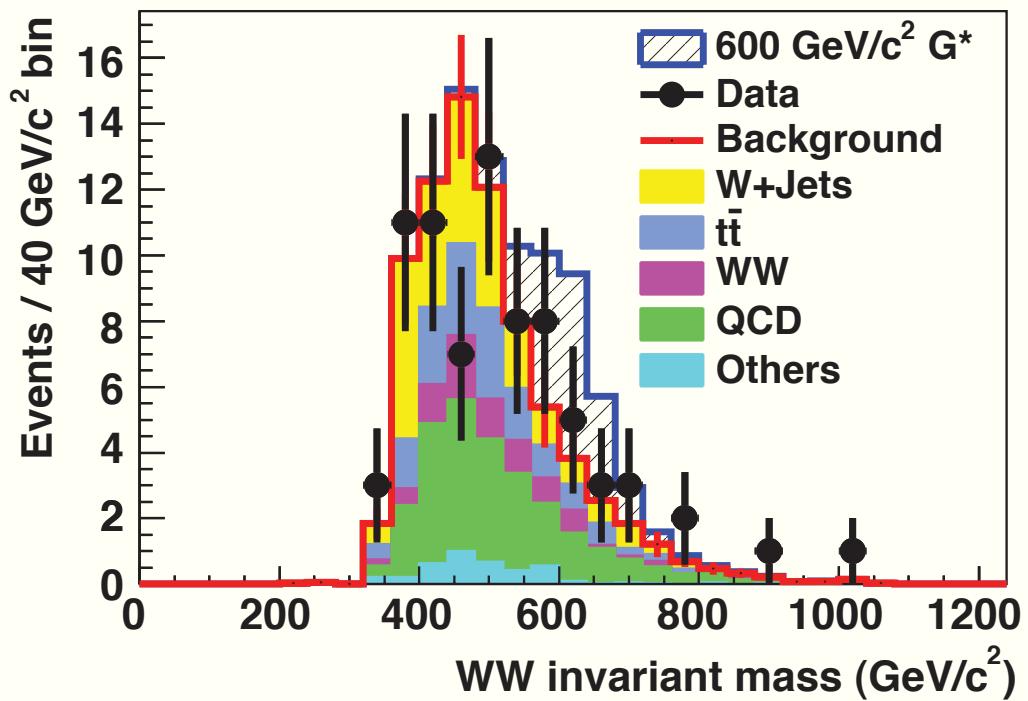
In 2.9 fb^{-1} , for $Z' \rightarrow WW$ expect 43 ± 6 events bkg; 51 observed
for $W' \rightarrow WZ$ expect 41 ± 7 events bkg; 38 observed



Excluded regions @ 95% C.L.: Z' mass $247 - 544 \text{ GeV}/c^2$
 W' mass $285 - 516 \text{ GeV}/c^2$

... and on the Randall-Sundrum graviton

In 2.9 fb^{-1} , expect 41 ± 7 events background; 38 observed



Excluded region @ 95% C.L.: G^* mass $< 607 \text{ GeV}/c^2$

PRL 104, 241801 (2010)

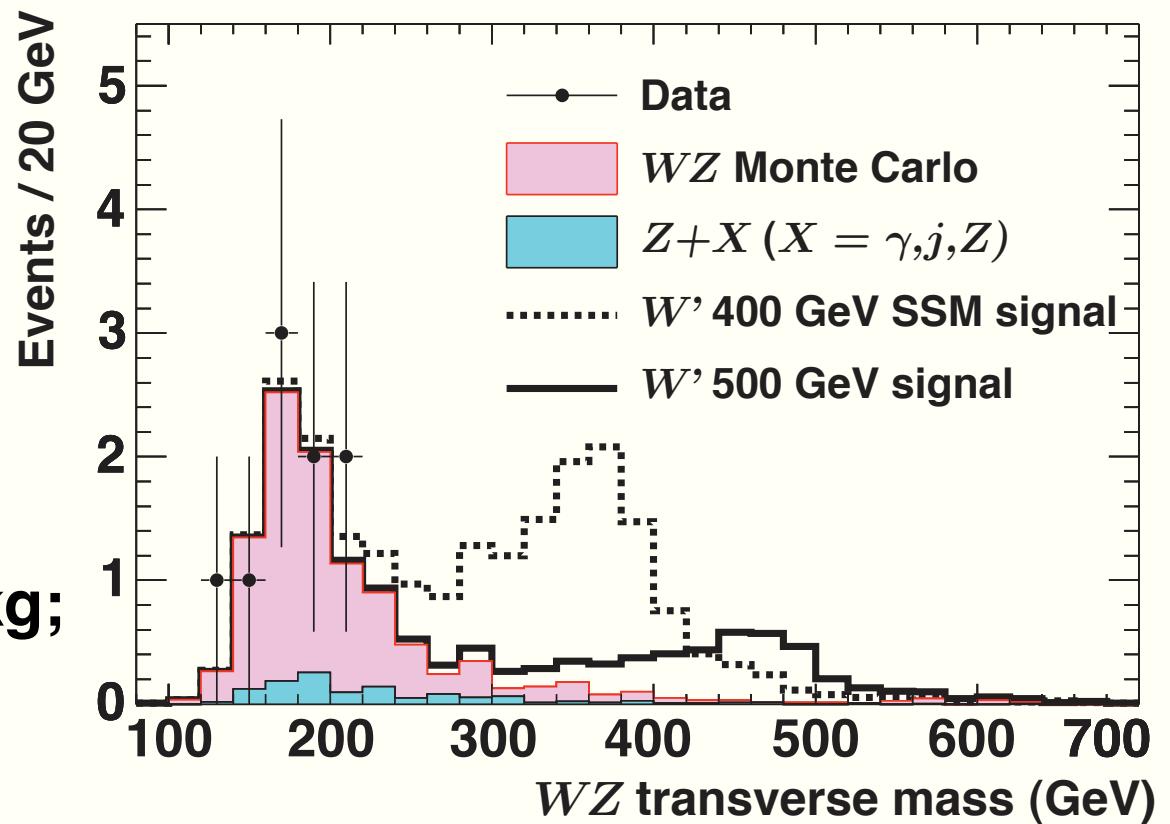
6) DØ investigated low-scale technicolor and other models with WZ resonance search

Examined previously unexplored region of Low-Scale Technicolor (LSTC) $M(\pi_T) \lesssim M(\rho_T)$ where $\rho_T \rightarrow WZ$

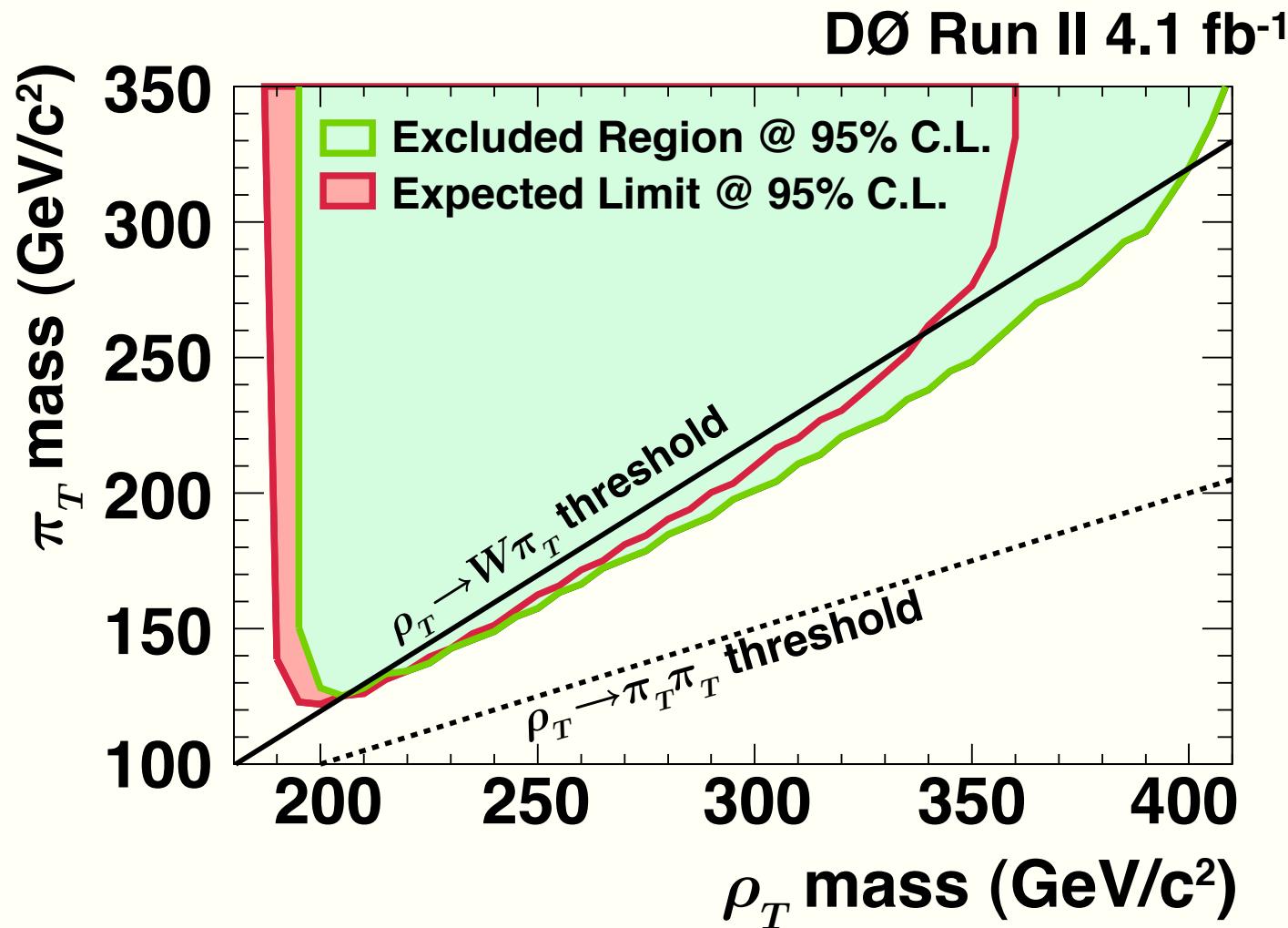
Also compare to W' from sequential SM

Require signature: $\ell\nu\ell\ell$ (fully leptonic)

In 4.1 fb^{-1} ,
expect 10.2 ± 1.6 events bkg;
9 observed

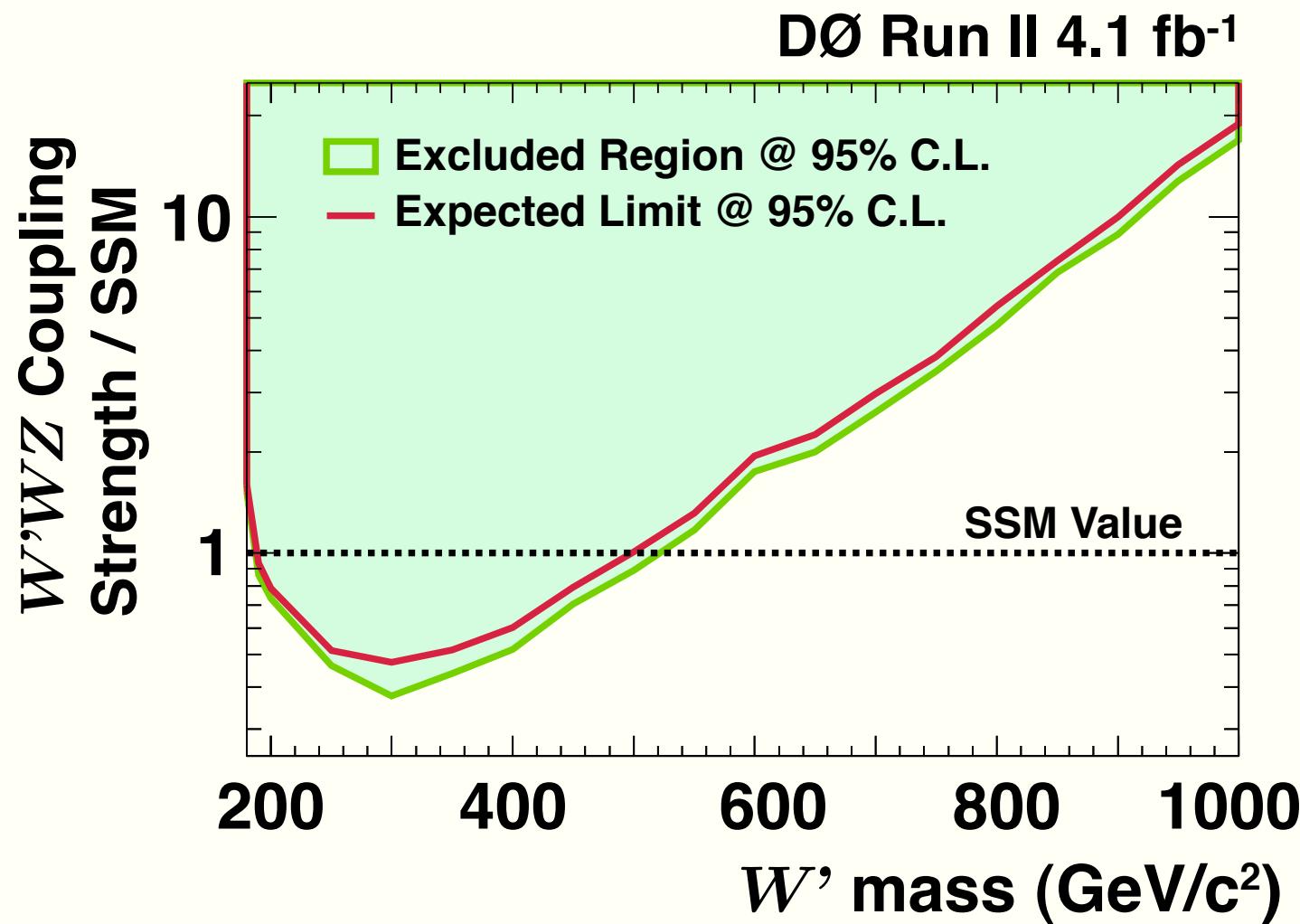


Limits were set on LSTC...



Excluded region @ 95% C.L.: ρ_T mass 208 – 408 GeV/c²
for $M(\rho_T) < M(\pi_T) + M(W)$

... and limits were set on SSM and other models



Excluded region @ 95% C.L.: W' mass 188 – 520 GeV/c² for SSM coupling strength

PRL 104, 061801 (2010)

We have examined lots of models!

Six analyses from CDF and DØ involving same-sign dileptons and WZ resonances were presented.

New Physics was not observed.

But lots more to do...

Both CDF and DØ have recorded $> 8 \text{ fb}^{-1}$.

Tevatron and detectors are running extremely well!

... and LHC experiments will join with searches too.

What's down the road for Beyond the Standard Model Physics?

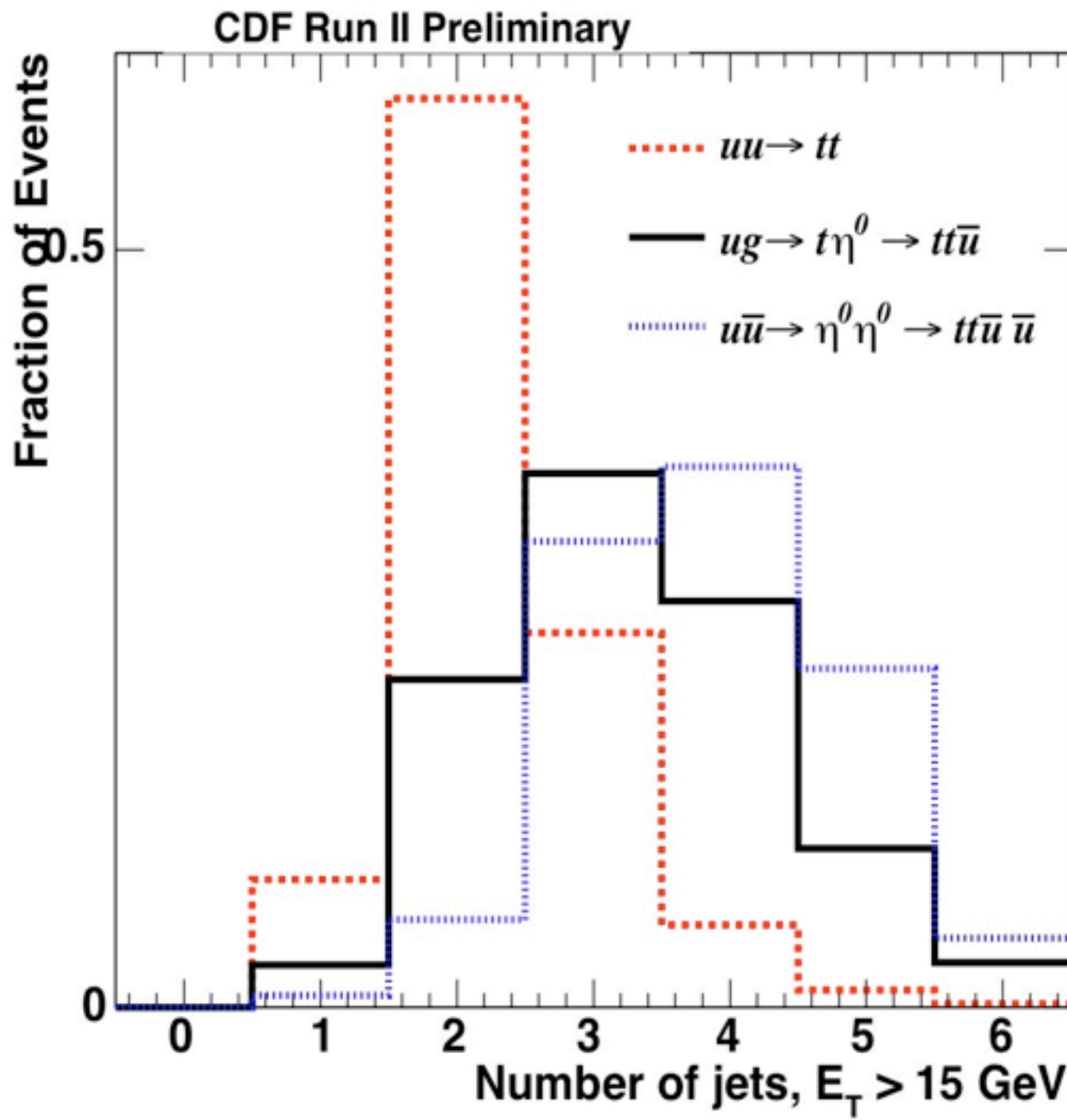
Hopefully not...



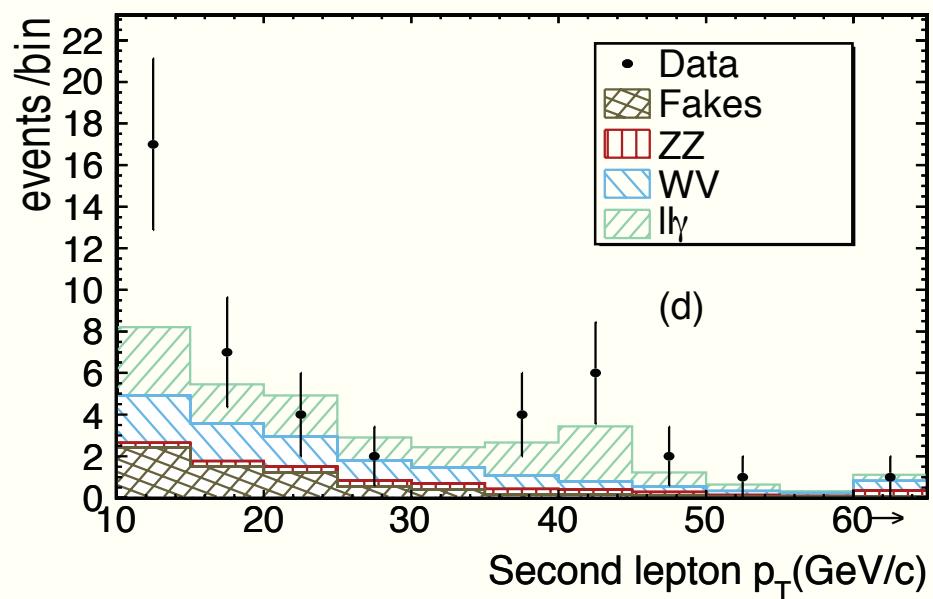
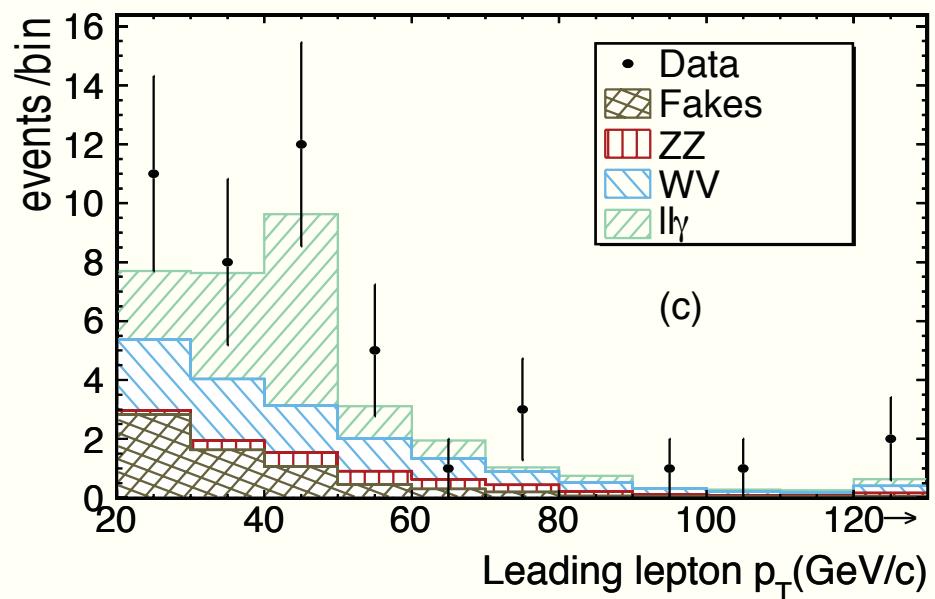
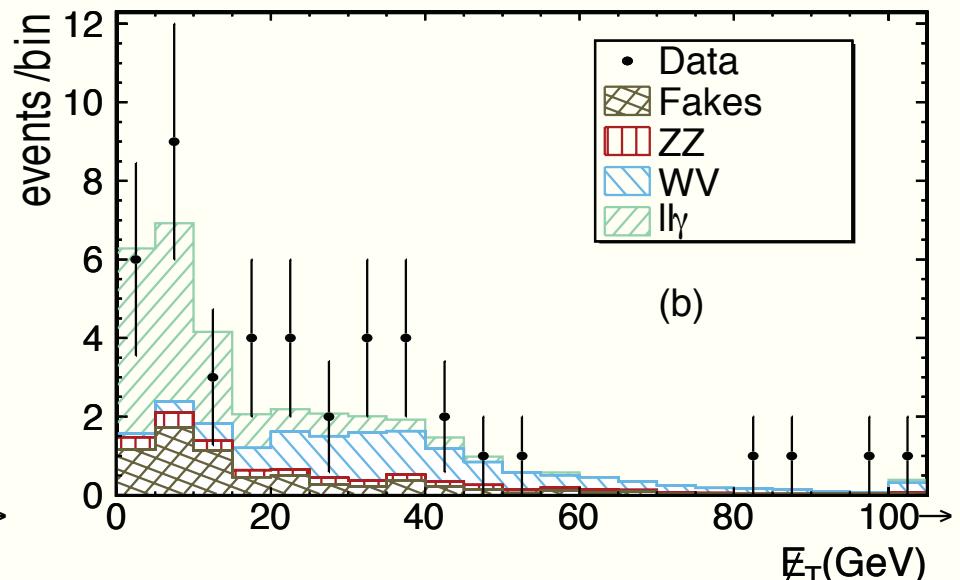
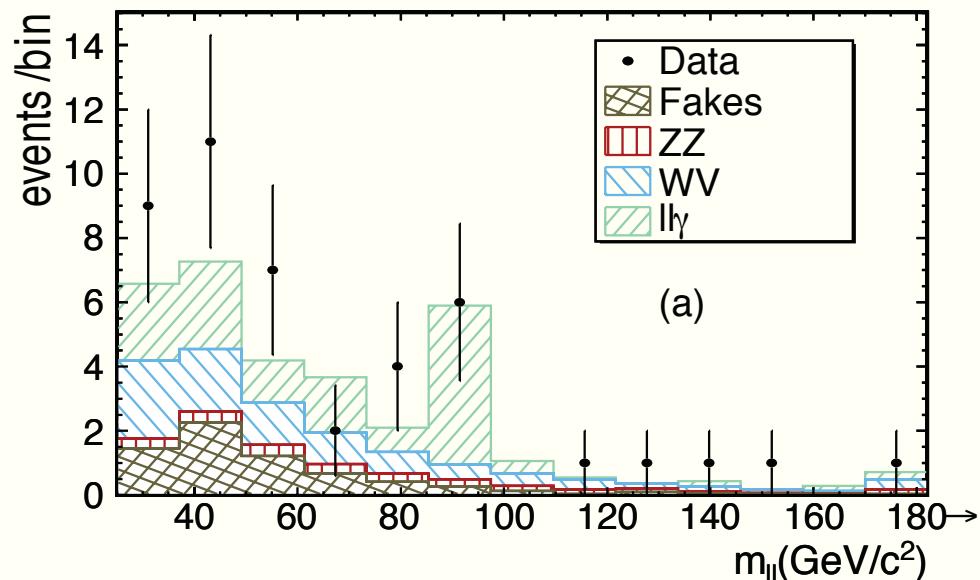
... but instead lots of exciting New Physics to untangle



BACKUP SLIDES BEYOND THIS POINT



CDF Model Independent Search



CDF W' Limit

